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Economic Commission for Europe

Inland Transport Committee

Working Party on Inland Water Transport

Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation

Fifty-third session

Geneva, 27-29 June 2018

Item 3 (b) of the provisional agenda

Inland waterways infrastructure:

Inventory of Main Standards and Parameters of the E Waterway Network ("Blue Book")

Draft amendments to the Inventory of Main Standards and Parameters of the E Waterway Network ("Blue Book")

Transmitted by the Governments of Belgium and Ukraine

I. Draft amendments to "Blue Book"

I. Under basic bottleneck for Ukraine, add the following line:

"Prypiat (E 40), from the Ukrainian/Belarus state border to Mouth — upgrading from class III to class IV is required."

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2. In table 1, "Navigational Characteristics of Main European Inland Waterways of International Importance", amend as follows (additions in bold, deletions strikethrough, footnotes will be renumbered when necessary):

E waterway	Section of E waterway	Length (km)	Maximum dimensions of vessels and pushed convoys which may be accommodated			Minimum height under bridges**** (m)	Class	Suitability for Combined transport**	Comments
			Length*** (m)	Width*** (m)	Draught (m)				
1	2	3	4	5	6	7	8	9	10
E 40	PRYPIAT PRAPYAT	62.5							Free-flowing
	Belarus/Ukraine border — mouth of the Prypiat Prapysat River		100.0/100.0	20.00/20.00	1.50 ¹	No restrictions	IV ¹³	B	
	DNIPRO	~~83.0~~ 81.5	~~150.0/150.0~~	18.00/18.00	2.65³	No restrictions	Va	A	Canalized
	Mouth of the Prypiat River — Kyiv (943.5 km — 862.0 km)		85.2/114.8	15.30/15.20	2.65 ²	No restrictions	Va	A	
	DNIPRO Kyiv — Kanivska Hydroelectric	~~134.0~~ 135.0	270.0/270.0	18.00/18.00	3.65³	No restrictions	Vb	A	Canalized
	Power Station (HPS) (~~856.0 km~~ ~~722.0 km~~) (862.0 km — 727.0 km)		114.1/170.0	13.23/15.20	3.65 ³	No restrictions	Vb	A	
	DNIPRO, Kanivska HPS — Kremenchutska HPS	~~146.0~~ 171.0	270.0/270.0	18.00/18.00	3.65³	13.20	Vb	A	Canalized
	727.0 222.0 km — 556.0 km		114.0/170.0	13.23/15.20	3.65 ³	13.20	Vb	A	
	DNIPRO Kremenchutska HPS	123.0	270.0/270.0	18.00/18.00	3.65³	No restrictions	Vb	A	Canalized

¹ Guaranteed depth of the channel designed for maximum draught of vessels 1.2 m.

² Guaranteed depth of the channel designed for maximum draught of vessels 2.2 m.

³ Guaranteed depth of the channel designed for maximum draught of vessels 3.2 m.

E waterway	Section of E waterway	Length (km)	Maximum dimensions of vessels and pushed convoys which may be accommodated			Minimum height under bridges**** (m)	Class	Suitability for Combined transport**	Comments
			Length*** (m)	Width*** (m)	Draught (m)				
I	2	3	4	5	6	7	8	9	10
	Seredniodniprovskaserednodniprovska HPS (556.0 km — 433.0 km)		138.3/170.0	16.70/15.20	3.65 ⁴	No restrictions	Vb	A	
	DNIPRO, Seredniodniprovsk HPS — Dniprovsk HPSDniptroges	128.0	270.0/270.0	18.00/18.00	3.65 ³	14.70	Vb	A	Canalized
	(433.0 km — 305.0 km)		138.3/170.0	16.70/15.20	3.65 ^{45,3}	14.70	Vb	A	
	DNIPRO	212.0	270.0/270.0	18.00/18.00	3.65 ³	No restrictions	Vb	A	Canalized
	Dniprovsk HPS Dniptroges — Kakhovska HPS (305.0 km — 93.0 km)		138.3/170.0	16.70/15.20	3.65 ⁴	No restrictions	Vb	A	
	DNIPRO	65.0	270.0/270.0	18.00/18.00	3.65 ³	No restrictions	Vb	A	Free-flowing
	Kakhovska HPS — Kherson (93.0 km — 28.0 km)		138.3/170.0	16.70/15.20	3.65 ⁴	No restrictions	Vb	A	
	DNIPRO	28.0	200.0/200.0	32.50/32.50	7.60	No restrictions	VII	A	Sea vessel route
	Kherson — Entry to Rvach Arm		200.0/200.0	32.50/32.50	7.60	No restrictions	VII	A	
E 40-01	KHERSONSKYI SEA CHANNEL, entry to Rvach Arm — leading line of Adzhyskolska Beak	40.0	200.0/200.0	32.50/32.50	7.60	No restrictions	VII	A	Sea vessel route
	DESNA	498.0 194.5	.../...	.../...	1.60	...	IV	A	Free-flowing
	From the mouth to Chernihiv (0.0 km — 498.0/194.5 km)		.../...	.../...	1.30	...	III	...	

E waterway	Section of E waterway	Length (km)	Maximum dimensions of vessels and pushed convoys which may be accommodated			Minimum height under bridges **** (m)	Class	Suitability for Combined transport **	Comments
			Length *** (m)	Width *** (m)	Draught (m)				
I	2	3	4	5	6	7	8	9	10
E 40-02	PIVDENNYI BUIH	81.4	215.0/215.0	32.50/32.50	10.30	No restrictions	VII	A	Sea vessel Route
	Buzko-Buzsko-Dniprovske- Lymanskyi Channel (BDLC), sections 1-13		215.0/215.0	32.50/32.50	10.30	No restrictions	VII	A	

3. In table 2, "Parameters of Locks of Inland Waterways of International Importance", for the Dnipro waterway, amend as follows (additions in bold, deletions strikethrough):

Section of E waterway	Dimension of locks			Comments
	Length (m)	Width (m)	Depth at sills (m)	
DNIPRO	150.0	18.00	4.00	~~Kyiv~~ Kyivskiy lock
Mouth of the ~~Prypiat~~ Pripyat River — Kherson	270.0	18.00	4.25	~~Kaniv~~ Kanivskiy lock
	270.0	18.00	3.85	~~Kremenchuk~~ Kremenchutskiy lock
	270.0	18.00	3.65	~~Kamianske (Dniprodzerzhynsk)~~ Dniprodzerzhynskiy lock
	120.0	18.00	4.40	~~Zaporizhya~~ Zaporizkiy three chambers lock
	290.0	18.00	5.50	~~Zaporizhya~~ Zaporizskiy one chamber lock
	270.0	18.00	3.65	~~Kakhovka~~ Kakhovskiy lock

4. In table 2, "Parameters of Locks of Inland Waterways of International Importance", for E 01-01, E 02 and E 04:

Section of E waterway	Dimension of locks			Comments
	Length (m)	Width (m)	Depth at sills (m)	
ZUID — WILLEMSVAART	65.0	7.50	2.50	Lock No. 15
	70.0	7.50	2.50	Lock No. 16
	~~50.0~~ 52.0	7.00	1.90	Bocholt and Lozen locks (Nos. 18 and 17)
GENT — OOSTENDE CANAL	~~80.7~~ 90.8	~~40.20~~ 11.75	2.50	Dammeport lock
LEIE	136.0	16.00	2.50 2.80	Sint-Baafs-Vijve lock
	115.0	~~12.40~~ 12.50	3.50 2.80	Harelbeke lock
BRUXELLES — SCHELDE CANAL	250.0	25.00	9.50	Wintam lock
	205.0	~~24.90~~ 24.00	6.50	Zemst lock

5. In table 3, "Technical Characteristics of Inland Navigation Ports of International Importance", for E-40 waterway, amend as follows (additions in bold, deletions strikethrough):

	E ports	Cargo handling capacity			Cargo handling equipment available for				Rail access **	Other characteristics and comments
		0.5-3.0 million tonnes	3.0-10.0 million tonnes	> 10.0 million tonnes	Containers **		RO-RO **			
					20'	40'				
I		2	3	4	5	6	7	8	9	
P 40-05	Kyiv (Dnipro, 856.0 862.0 km)			X	X		-	X	Bulk and general cargo	
P 40-06	Cherkassy Cherkasy (Dnipro, 653.0 km)		X		X	-	-	X	Bulk and general cargo	
P 40-07bis	Poltava Poltavskyi Ore Mining and Processing Enterprise (Dnipro, 521.0 km)		X		-	-	-	X	Ore, minerals	
P 40-08bis	Cargo Handling terminal (Dnipro, 422.0 km)	X			-	-	-	X	Bulk and general cargo	
P 40-10	Zaporizhzhya Zaporizhzhia (Dnipro, 308.0 306.0 km)			X	X	X	-	X	Bulk and general cargo, lighters	
P 40-11	Nova Kakhovka (Dnipro, 96.0 94.0 km)	X			-	-	-	-	Bulk and general cargo	
P 40-02-01	Mykolaiv, river port (Pivdenny Pivdennyi Buh, 40.0 km)	X			...	...	...	...	Cereals, scrap, minerals	
P 40-02-02	Mykolaiv, sea port (Pivdenny Pivdennyi Buh, 35.0 km)		X		X	X	-	X	Timber, oil products, metals, cereals, bulk cargo, scrap	

	E ports	Cargo handling capacity				Cargo handling equipment available for				Rail access **	Other characteristics and comments	
		0.5-3.0 million tonnes			3.0-10.0 million tonnes	> 10.0 million tonnes	Containers **					RO-RO **
		2	3	4			20'	40'				
	I										9	
P 40-02-03	Dnipro-Buhskyi Buzkyi (Pivdenny Pivdennyi Buh, 16.0 km)		X			-	-		-	X	Ore, general cargo	
P 80-09-02	Kilia Kilia (Danube — Kiliuske Mouth, 47.0 km)	X				X	-		-	-	General cargo	
P 80-09-03	Ust-Dunaisk (Danube — Kiliuske Mouth, 0 km)			X		X	X		-	-	General and bulk cargo ⁴	

⁴ Water area of Ust-Dunaisk Port basin (Danube-Kiliiske Mouth, 0 km) is closed for navigation.

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Economic Commission for Europe**Inland Transport Committee****Working Party on Inland Water Transport****Working Party on the Standardization of Technical
and Safety Requirements in Inland Navigation****Fifty-third session**

Geneva, 27-29 June 2018

Item 4 (a) of the provisional agenda

Standardization of technical and safety requirements in inland navigation:**European Code for Inland Waterways (CEVNI) (Resolution No. 24, revision 5)****Outcome of the twenty-seventh meeting of the CEVNI Expert
Group and amendments to the European Code for Inland
Waterways****Note by the secretariat****Mandate**

1. This document is submitted in line with cluster 5: Inland Waterway Transport, paragraph 5.1 of the programme of work 2018-2019 (ECE/TRANS/SC.3/2017/24) adopted by the Inland Transport Committee at its eightieth session (20-23 February 2018).
2. At its fifty-second session, the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation took note of the decisions of the twenty-seventh meeting of the CEVNI Expert Group held on 13 February 2018. The full report of the meeting, including amendment proposals for CEVNI, is reproduced in the Annex.

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Annex

Decisions of the twenty-seventh meeting of the CEVNI Expert Group

1. The CEVNI Expert Group held its twenty-seventh meeting on 13 February 2018 back-to-back with the fifty-second session of the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation (SC.3/WP.3, 14-16 February 2018).

2. The meeting was attended by Mr. B. Birkhuber (Austria), Ms. H. Liégeois (Belgium), Ms. L. Hlavenkova (Slovakia), Mr. S. Tzarnakliyski (Danube Commission, hereafter DC), Ms. P. Brückner (Mosel Commission), Mr. Z. Milkovic (International Sava River Basin Commission, hereafter SC), Mr. S. Carruthers (European Boating Association, hereafter EBA), Ms. C. Paddison (EBA) and Ms. V. Ivanova (UNECE secretariat).

3. The Central Commission for the Navigation on the Rhine, hereafter CCNR, was not able to attend the meeting.

4. The Group adopted the provisional agenda (CEVNI EG/2018/1) as modified below:

I. Adoption of the minutes of the twenty-sixth meeting.

Document: CEVNI EG/2017/9

II. General exchange of information.

III. Amendment proposal to Article 7.08 (a new paragraph 4).

Document: CEVNI EG/2017/6

IV. Amendment proposals on the basis of amendments to Articles 1.07, 4.07, 7.06, 12.01, annex 7 and a new annex 12 of to the Police Regulations for the Navigation of the Rhine and to Articles 1.01 and 9.05 of the Police Regulations for the Navigation of the Mosel.

Document: ECE/TRANS/SC.3/2017/10

V. Amendment proposal to Chapter 9.

Document: CEVNI EG/2018/3/Rev.1

VI. Draft revision 3 of the Signs and Signals on Inland Waterways (SIGNI)

Documents: ECE/TRANS/SC.3/2017/11/Rev.1, CEVNI EG/2017/3

VII. Amendment proposals to Articles 4.05, 4.07 and Chapter 10 (transmitted by Austria)

Document: CEVNI EG/2018/4

VIII. Other business:

(a) Amendments to CEVNI that may emanate from amendments to Articles 1.10 and 4.07 of the Police Regulations for the Navigation of the Mosel (RPNM) (transmitted by MC)

Document: CEVNI EG/2018/5

(b) Information from CCNR about recent amendments to the Police Regulations for the Navigation of the Rhine (RPNR) introduced by Protocols Nos. 16, 17 and 19 adopted at the autumn session in 2017

Document: Informal document SC.3/WP.3 No. 6 (2018)

IX Next meeting.

I. Adoption of the minutes of the twenty-sixth meeting

5. The Group adopted the minutes of its twenty-sixth meeting held on 3 October 2017 in Geneva.

II. General exchange of information

6. The Group mentioned that no updates were available since the last meeting.
7. The Group was informed about the publication on the implementation of CEVNI 5 that would be available in the end of February as ECE/TRANS/266.

III. Amendment proposals to Article 7.08 (a new paragraph 4)

8. The Group finalized the text of the new paragraph 4 as follows:
- 4. An efficient watch kept on one vessel in accordance with paragraphs 1 and 2 can be responsible for the watch on the several other vessels referred to in these paragraphs only in case when vessels are coupled together in such a way that the safe crossing from one to other is provided for.**
9. The Group asked the secretariat to transmit this proposal to SC.3/WP.3.

IV. Amendment proposals on the basis of amendments to Articles 1.07, 4.07, 7.06, 12.01, annex 7 and a new annex 12 of to the Police Regulations for the Navigation of the Rhine and to Articles 1.01 and 9.05 of the Police Regulations for the Navigation of the Mosel

10. The Group took note of the clarification by MC about the amendments introduced to RPNM and agreed to start a detailed discussion of an amendment proposal to CEVNI based on ECE/TRANS/SC.3/2017/10 at its next meeting.

V. Amendment proposal to Chapter 9

11. The Group discussed the proposal on updating Chapter 9 (CEVNI EG/2018/3/Rev.1) and decided:

(a) In Article 9.01, para.1, *replace* "in particular, the provisions listed in this Chapter" *with* "that are listed in this Chapter";

(b) in Article 9.02, para. 6 (d), *replace* "turn-and-bank indicator" *with* "**rate-of-turn** indicator" in the English text;

(c) In Article 9.04, para. 7, in the end, *add* "**for ferry-boats**";

(d) *Modify* para. 9 as follows:

With respect to article 3.27, the competent authorities may prescribe a yellow **or red** scintillating light instead of the blue **light** for fire-fighting and rescue vessels;

(e) *Delete* para. 4 in Article 9.05;

- (f) *Modify* Article 9.09 as follows:

With respect to article ~~8.02~~ **8.01** paragraph 4, the competent authorities may **waive the requirement** that, if the vessel has stopped, all engines and auxiliary machinery must be stopped or unplugged.

12. The Group decided that Chapter 9 and possibly Chapter 10 needed a revision. For this purpose, the secretariat was asked to prepare a comparison of Chapter 10 and the Convention on Collection, Deposit and Reception of Waste Produced during Navigation on the Rhine and Inland Waterways (CDNI), version 2014. Members of the Group were invited to submit their proposals on the revision of Chapter 9 by the next meeting.

VI. Draft revision 3 of the Signs and Signals on Inland Waterways (SIGNI)

Documents: ECE/TRANS/SC.3/2017/11/Rev.1, CEVNI EG/2018/6

13. The Group considered the statement proposal of DC in connection with the revision of SIGNI (CEVNI EG/2018/6) and agreed on the following:

- (a) a new SIGNI shall include rules on the practical implementation of the signals, which are already used in CEVNI. Other signs and markings shall be deleted;
- (b) The signals used in CEVNI shall get into SIGNI with the same description/definition and same visualization;
- (c) In case of introducing new or additional signals in SIGNI that do not exist in CEVNI, this shall be completed in both documents in parallel at the same time.

14. In particular, the Group mentioned that Chapters 5, 8 and 9 should be brought in line with CEVNI 5. For this purpose, for the next meeting the secretariat will prepare draft amendments for Chapter 5, and River Commissions will prepare draft amendments to Chapters 8 and 9.

VII. Amendment proposals to Articles 4.05, 4.07 and Chapter 10 (transmitted by Austria)

15. The Group discussed document CEVNI EG/2018/4 transmitted by Austria and proposed the following amendments to CEVNI:

- (a) In article 4.05, paragraph 1, *replace* “carried on board a vessel” *with* “carried on board a vessel, an assembly of floating material or a floating establishment”
- (b) In Article 4.07, paragraph 4 (m), *delete* “(GNSS/DGNSS)”;
- (c) *Delete* Article 4.07, paragraph 4 (n).;
- (d) In article 10.01 paragraph 1 (c), (g) and (h) and paragraph 2 (b), *replace* the word “occurring” *with* “generated”;
- (e) *Modify* Article 10.06, para. 1, sentence 1, as follows:

English text:

All ~~motorized~~ vessels, whose main or auxiliary engines, with the exception of the engines of the anchor winches, are combustion engines, excluding

small craft,¹ shall carry on board a valid used oil log issued by a competent authority and in line with the model contained in annex 9.

French text:

Chaque ~~bateau motorisé~~ bâtiment dont les moteurs principaux ou auxiliaires, à l'exclusion des moteurs des guindeaux d'ancres, sont des ~~moteurs à combustion interne~~, à l'exception des menues embarcations, doit avoir à son bord un carnet de contrôle des huiles usagées valable, délivré par une autorité compétente selon le modèle de l'annexe 9.

(f) In Article 10.07, para. 1, *delete* "motorized".

VIII. Other business

A. Amendments to CEVNI that may emanate from amendments to Articles 1.10 and 4.07 of the Police Regulations for the Navigation of the Mosel (RPNM) (transmitted by MC)

16. The Group took note of the information by Ms. Brückner about the recent amendments to Articles 1.10 and 4.07 of RPNM (CEVNI EG 2018/5).

17. The Group proposed the following amendments:

(a) In Article 4.07, para. 4 (c), *add*:

Type of vessel or convoy **according to the VTT Standard for inland navigation**

(b) In Article 9.02, para. 6 (e) and (g), *modify*:

(e) Radiotelephone certificate (**certificate of operator of radiotelephone service on inland waterways**) delivered according to the relevant international and regional agreements;

(g) Handbook on radiotelephony (**radiocommunication**) in inland navigation, (general part and regional part).

B. Information from CCNR about recent amendments to the Police Regulations for the Navigation of the Rhine (RPNR) introduced by Protocols Nos. 16, 17 and 19 adopted at the autumn session in 2017

18. The Group took note of the information transmitted by CCNR (Informal document SC.3/WP.3 No. 6 (2018)) and asked the secretariat to issue it as a working document for the fifty-third session of SC.3/WP.3.

IX. Next meeting

19. The CEVNI Expert Group agreed on the following preliminary date for its twenty-eighth meeting to be 26 June 2018, back-to-back with the fifty-third session of SC.3/WP.3.

¹ See CEVNI EG/2017/9, para. 14.

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Item 4 (b) of the provisional agenda

Standardization of technical and safety requirements in inland navigation:**Signs and Signals on Inland Waterways (SIGNI) (Resolution No. 22, revision 2)****IALA Guidelines on the "Selection of rhythmic characters
and synchronization of lights for aids to navigation (G 1116)"
Edition 1.0, December 2016****Transmitted by the International Association of Marine Aids to
Navigation and Lighthouse Authorities (IALA)****Mandate**

1. This document is submitted in line with cluster 5: Inland Waterway Transport, paragraph 5.1 of the programme of work 2018-2019 (ECE/TRANS/SC.3/2017/24) adopted by the Inland Transport Committee at its eightieth session (20-23 February 2018).
2. At its fifty-second session, the Working Party on the Standardization of Technical and Safety Requirements in Inland Navigation decided to consider IALA Guidelines "Selection of rhythmic characters and synchronization of lights for aids to navigation (G1116, December 2016)" as a basis for possible amendments to SIGNI (ECE/TRANS/SC.3/WP.3/104, para. 32). The IALA Guidelines are reproduced in the annex.

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Annex

1. Introduction

This document is intended for the provision of guidance to the technical aspects of selecting the rhythmic characters as defined in Recommendation E-110 [1]. It includes temporal considerations, selection of colours, the use of the fixed and flashing character, user considerations, synchronisation and sequencing.

While the selection of a rhythmic character for floating AtoN is a straightforward process strictly guided by E-110, there are many options for selection of a rhythmic character for a fixed AtoN. When selecting a rhythmic character for a fixed AtoN, one should first consider the navigational aspects (significant difference from nearby marks; conspicuity, terrain and the background lighting; etc.). Then the technical aspects, such as, power requirements must be considered which may require a second iteration of the character selection.

2. Background

Historically, there were technical limitations in the achieving the characters available in E-110. However, in the foreseeable future the majority of AtoN lights on fixed and floating AtoN will be converted to Light-Emitting Diode (LED) or other emerging light sources. There is much more scope in the selection of rhythmic characters to exploit with these new technologies.

3. Scope and purpose

This document applies to marine aids to navigation signal lights on fixed and floating applications. It is intended for provision of integrated guidance on the following topics:

- General temporal considerations
- Selection of colours
- Flash duration
- Character length
- Use of simultaneous fixed and flashing signals
- Synchronisation and sequencing
- Sharing of good practice by inclusion of examples in appendices.

4. General temporal considerations

4.1. Considerations for period selection

The persistence of vision of a light, after extinction of the light, can reach 0.15 second. If the duration of an interval of darkness in a rhythmic character is made too short, the flashes may merge, obstructing identification of an AtoN. Therefore, duration of an eclipse should not be reduced to under 0.15 second.

The periods of the characters of rhythmic lights should be selected in accordance with location specific navigational requirements and results of corresponding risk assessments.

Restricted areas, heavier traffic and higher vessel speeds need shorter periods and longer or more flashes in characters allowing more rapid and frequent identification. In less demanding areas with little traffic and slower speeds, it is more acceptable to use longer characters.

Historically, periods of up to 30 seconds have been used for major landfall lights. Where possible in new installations, a shorter period should be considered in order to reduce the time necessary to identify the AtoN.

In order to maintain spatial awareness in demanding areas, consideration should be given to limiting the eclipse length. Trials have shown that limiting the eclipse length to 8 seconds has proved to be effective [23]. When longer eclipse is required to avoid confusion with other lights, introduction of a fixed and flashing character can be used to retain spatial awareness at close ranges. Fixed flashing can also be considered for shorter eclipses when high-speed craft or close manoeuvring to the aid to navigation is expected.

4.2. Considerations for flash length selection

To ensure that their quick lights can be discriminated, an authority should preferably choose the rates for all its quick lights to be 60, very quick lights 120, and ultra-quick lights 240 flashes per minute. The repetition rate for ultra-quick lights should not exceed 300 flashes per minute because at faster rates the sequence of flashes might resemble appearances of steady light in some circumstances.

Discrimination of different rates of flashing is not immediately easy unless there is a ratio of at least three to one between the rates. If this ratio cannot be attained, particular care will be required if flashing, quick, very quick and ultra-quick lights of the same colour in the same area are to be correctly and readily identified. Other distinctions should be made, if possible, between the characters, such as making periods clearly dissimilar or the numbers in groups different.

The term "long flash", which is used in the descriptions of the long-flashing light and of the light characters reserved for south cardinal marks, means an appearance of light of not less than 2 seconds duration. The term "short flash" is not commonly used and does not appear in the Classification [1]. If an authority requires discrimination between two flashing lights that only differ in having flashes of different durations, then the longer flash should be described as "long flash" and be of not less than 2 seconds duration, and the shorter flash may be described as "short flash", but its length is no more than one third of the duration of the longer flash.

Several countries have defined specific rhythmic character subsets for use mainly on their floating marks. Examples of national flash characters are provided in [11], [12] and [13]. An example of implementing different rhythmic characters for a channel is to increase the number of flashes in accordance with the distance along the channel. Another example would be to use a different flash character of lateral buoy lights at a change in channel direction.

4.3. Considerations for flash shape selection

Traditionally, flash shape has been confined by technology, resulting in flash profile that cannot be precisely controlled. Gaussian flash profiles produced by rotating optics and incandescent sources had a side effect of perception of the flash length changing in accordance with the viewing distance that provided certain ranging capability at the far end. Standard rectangular flash shapes produced by LED light sources retain same temporal perception regardless of the viewing distance.

However, with the use of modern control techniques and LED light sources, bespoke flash profiles can be achieved which may assist in conspicuity and ranging. Impact of flash profile manipulation on effective luminous intensity of the flash pulse is explained in [3].

Figure 1

Typical flash shapes (pulse profiles) produced by flashing incandescent light sources (left), any light sources in rotating optics (middle), and rectangular LED pulse (right)



5. Selection of colour

It is safer to assume that a confusion between white and yellow as colours for lights is liable to occur, and therefore the rhythmic character of a yellow light should always be chosen with the understanding that the colour of the light might be mistaken for white.

A green or blue light that is showing flashes of very short duration can be mistaken for a white light. Therefore, authorities should take care that the colour of a green or blue light is clearly recognizable at the maximum required range if the duration of a flash in the rhythmic character is very short. It is advisable for authorities to avoid choosing rhythmic characters with high rates of flashing for blue or green lights.

Use of colour in AtoN signalling is described in detail in the IALA Maritime Buoyage System.

6. Use of fixed and flashing signals

Replacing an eclipse of a rhythmic character of AtoN light with a low-intensity light signal enhances the ability of the mariner to maintain spatial awareness and improves identification at close range. In cases when traditional rotating optics of a lighthouse are replaced with flashing LED lights, implementation of fixed and flashing character creates the effect similar to the residual light between flashes of rotating optics. Trials have shown that a fixed light signal component of 1 per cent of peak luminous intensity can be considered sufficient for majority of fixed and flashing character applications. Careful consideration of conspicuity implications is necessary to avoid reduction of fixed/flashing component contrast by fixed luminous intensity level above 5 per cent (up to 10 per cent in high background lighting conditions).

The fixed component can be applied to a number of rhythmic characters, if the low intensity phase (longest eclipse in the group character) is longer than the high intensity phase (flash). Nevertheless, fixed phase can be also used with occulting characters. For charting purposes, placement of an "F" in front of the character abbreviation signifies application of a combination of the low intensity fixed light signal with the main character, shown in Figure II. For example, the following abbreviations are already in use: FFI, Flso, FLF.

Figure II
Chart fragment showing a 15 NM FFI light (Estonian AtoN 935, Sörve Lighthouse)



This class of light character should be used with care because the fixed component of the light may not be visible at all times over the same distance as the rhythmic component due to environmental factors.

Some results of trials and application examples are provided in [9] and [10].

7. Synchronisation and sequencing of AtoN lights

7.1. Introduction to synchronisation and sequencing

Synchronisation and sequencing of AtoN lights are useful methods of increasing spatial awareness of mariners by improving the overall conspicuity of AtoN lights especially in built-up areas and areas with background lighting.

Both can be combined with fixed and flashing rhythmic characters.

Where possible, effect of sequencing of lights can be tried out on an AtoN lights simulator before deployment to evaluate the benefits.

Improved availability of GNSS timing signals provides a cost efficient method for synchronisation and sequencing of AtoN lights. AtoN light units with integrated GNSS receiver modules are offered at relatively low cost by a number of manufacturers.

In addition to the objective of this Guideline, there are other applications where synchronisation may apply, as reflected in corresponding IALA documentation addressing marking of manmade structures [21], wind farms [22], or on other types of objects, such as wrecks, or when the identification of the “geometry” is relevant to the mariner.

7.2. Application of synchronisation and sequencing

In seeking to meet the navigational requirement as identified by risk assessment, the option of using synchronised and/or sequential lights provides a useful augmentation/enhancement to conventional AtoN lights when viewed against background lighting.

Synchronising of two or more flashing lights is already in use in signalling systems for various transport systems, including road, rail, aviation, and maritime. Historically, synchronisation has been used in the maritime world for leading lights. The purpose of synchronising is to increase the conspicuity of the signal, and/or to indicate that the two or more lights are associated in some manner. For example, if two buoys form a "gate" in a channel, the lights on them might be synchronised to make that gate pair more conspicuous, improving spatial awareness.

Sequencing of lights occurs when a series of lights are flashed in a time sequence to show the geographical relationship between them. Such a set of lights is sometimes likened to a so-called "flare path" or "runway" effect. In certain applications the number of flashes in the rhythmic characters of associated AtoN lights is increased (decreased) in progression along the fairway while only two of such lights are visible to a mariner at a time.

It is also possible to combine the two effects, so that, for example, if there is a channel marked by pairs of buoys, the lights on each pair are synchronised, and in addition, the paired lights are set to be in a time sequence along the length of the channel.

In each case, the objective is to help the mariner distinguish which lights are pairs of buoys (or beacons) marking a channel, and in addition to indicate which pairs are closest and which are more distant.

Following extensive trials [14] and experience gained with both synchronised and sequential AtoN, it is clear that two key benefits can result from their use:

- Synchronised lights provide high impact conspicuity

They draw the observer's eye to their presence and overcome background lighting due to their regular and combined effect.

- Sequential lights provide directional awareness and improve positioning within a system, e.g. fairway

The observer experiences visual movement in the horizontal plane.

The results of a number of these trials are available at the IALA Wiki.

7.3. Considerations for implementation of synchronisation

The flashing sequences of AtoN can be synchronised in a number of different ways. The devices should flash in a particular order for the fairway to be the most conspicuous to the mariner. Guidance based on current best practice is provided below.

7.3.1. Testing configuration for optimum conspicuity

It is important to test or simulate the synchronisation of flashing lights on one fairway in different conditions before making decisions on the synchronisation method to be introduced. This will allow an assessment to be made as to the extent that the visibility of the fairway can be improved. Tests should also involve affected mariners in order to ensure that the optimum system of synchronisation is implemented for a particular application.

7.3.2. Logical grouping of lights

Fairway turning points can be used to divide the fairway into sections. Lateral marks of the same fairway section could be synchronised, after which the aids marking the next section could be turned on. In order for the various fairway sections to stand out they should have similar characters. If this is not possible, the flashing sequences should be in multiples of each other's light periods.

Another possible option would be to follow the example of airport runway lights, which are turned on in sequence (consecutively). This alternative could also be utilised to guide vessels to port, however, this may look peculiar when leaving port. In this alternative, the flashing sequences at the ends of the fairway should be different from those in the middle. This method is not advisable in a shipping lane where the AtoN are not placed at equal intervals. As the distances vary, it is not possible to create an "approach effect" similar to an airport.

A third option would be to synchronise the different sides of the fairway. Using this method, the direction of the fairway could be highly visible but detecting its width could be difficult.

7.3.3. Use of different characters

Different characters can be used effectively to identify the beginning of a fairway or change in the fairway. For example, the first two buoys or channel markers could have a different character from the rest of the channel, whilst remaining synchronised.

The character period of synchronised lights should be sufficiently short such that the observer can see those aids as frequently as possible.

7.3.4. Sequential flashing

For lights flashing sequentially, the sync delay needs to be determined taking into account the geometry of the channel and in particular the paired buoy spacing. As a guide - "the closer the buoys are together the shorter the delay may be".

The geographical spacing between synchronised lights within a group, on fixed or floating aids, should be such that the group as a whole is normally within the observer's field of view.

When selecting flash character of sequencing lights and/or pairs, effect of sync failure on identification of such lights should be considered.

7.3.5. Leading lights

Selection of characters and management of synchronised leading lights ([20], [15]) should be such that the front and rear lights can be identified easily, and an overlap of their flash "on" time can still occur in the event of sync failure.

Special consideration should be taken in the design of synchronised leading lights to ensure that in the event of the failure of one lead, a single light is not mistakenly paired with an apparently synchronised external source such as its reflection on water. This consideration could include an automatic disabling of the second light if after risk assessment this is required.

7.3.6. Other considerations

1. The geographical layout and mix of the aids to navigation, channel or port approach where synchronised aids are deployed should be considered as a whole before decisions are made to establish such aids.
2. The likely sea state and prevailing visibility, i.e. local conditions, should be considered when planning to use synchronised or sequential lights in a waterway.
3. At dusk when the lights first turn on, and on occasion due to synchronisation signal loss, there may be a period of time where one of more of the lights will not be in synch,

therefore, consideration should be made to the general layout of the aids to navigation to ensure the mariner can still identify the channel.

4. The preference of using grouped synchronisation over sequential synchronisation may be made to avoid confusion to the mariner when transiting in an opposite direction to the sequential flashing.

5. Promulgation of information by way of notice to mariners must be carried out informing the mariners when a synchronised system is put in place.

6. Affected stakeholders should be consulted when designing the synchronised system.

7.4. Limitations of synchronisation

7.4.1. Environmental limitations

The application of synchronised and/or sequential aids to navigation does not necessarily provide the mariner with positional information. Synchronised lights provide spatial awareness and orientation within a channel or system of aids to navigation. There are physical limitations with regard to the installation of equipment required for synchronisation systems, e.g. lights synchronised using the GNSS must ensure that the GNSS sensor has an unobscured view of the sky in order to receive regular timing signal updates. Atmospheric conditions may affect the signal strength for radio synchronisation systems.

It should be considered that power requirements to provide a synchronised light system will in general, be a little greater. The impact of synchronised/sequential lights can be adversely affected by: buoy stability, visibility, excessive height of eye vis-à-vis vertical divergence, and general adverse weather and sea conditions (in a manner similar to conventional marking).

7.4.2. Maximum slippage time

To ensure the mariner can clearly ascertain synchronised groupings the timing error between synchronised lights should not be greater than 50 ms [12].

7.4.3. Minimum angular separation

To ensure clear separation of individual synchronised lights can still be made, it is recommended that there should be a minimum angular separation of 5 minutes of arc, subtended at the observer [12]. Lights too close together may be appearing as a single light of a unique and different colour.

8. Acronyms

AtoN Aid to Navigation

FFI Fixed and Flashing

FIso Fixed and Isophase

FLFI Fixed and Long Flashing

GNSS Global Navigation Satellite System

GPS Global Positioning System. Operated by the Government of the United States

IALA International Association of Marine Aids to Navigation and Lighthouse Authorities -

AISM LED Light-Emitting Diode

ms millisecond(s)

9. References

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